Forest Health Protection

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Special Project Report

Date: February 25, 2009
File Code: 3440

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To: District Ranger, Almanor Ranger District, Lassen National Forest

Subject: Red turpentine beetle infestation in the 2004 Prattville Underburn: Results of the Forest Health Protection Administrative Study (NE-SPR-09-01)

Thank you for allowing Forest Health Protection (FHP) to implement and complete the monitoring of 192 fire-injured and red turpentine beetle (RTB) attacked ponderosa pine trees in the 2004 Prattville Underburn.

BACKGROUND

This monitoring effort was initiated following a prescribed fire conducted between late April and early June 2004 in the Prattville ponderosa pine plantation that resulted in several fire-injured trees being heavily attacked by RTB. Data were collected during August 2004 and trees were monitored annually for changes in condition through October 2008. 193 trees, ranging from 9 - 20" diameter breast height (DBH), were included in the study; all were ponderosa pine except for one sugar pine which was dropped for this analysis (Tables 1 and 2). Data collection methods for the Prattville Underburn monitoring effort, including some preliminary results, RTB biology and historic reports of RTB activity in California are documented in the 2005 FHP Special Report titled *Red turpentine beetle infestation following underburning in pine stands* (NE-SPR-05-05)(Appendix A).

Table 3 - *Mean characteristics of variables for fire-injured ponderosa pine. P-values test differences between live and dead values.*

Variable[1]	Mean (n=192)	SE	Range	Live Mean (n=108)	Dead Mean (n=84)	p-value
DBH	14.2	2.4	9-20	14.6	13.6	0.7098
PCLK	18.4	14.0	0-62	12.8	25.7	0.0056
CKR*	1.5	1.4	0-4	1.0	2.1	0.0935
RTB	18.7	19.1	1-107	16.6	21.4	<0.0001

[1] DBH – diameter at breast height (in); PCLK – percent crown length killed; CKR – cambium kill rating; RTB – number of pitch tubes.

* Rating of 0-4 is based on a cambium sample taken in each of four equally spaced directions near ground level. A rating of 0 is equal to no fire damage for any sample and 4 is dead cambium at each sample location.

RESULTS

Trees with limited crown injuries were selected for this monitoring study to better quantify the impacts of RTB attacks on tree survival (i.e. trees that received high levels of crown injury were avoided since they were likely to die regardless of RTB attacks). Nearly all of the study trees had greater than 50 % of their original live crown length remaining and a majority of the trees had greater than 75 % of their original live crown length (Table 3). Cambium injury was evaluated for each study tree to compare with recorded RTB attack levels and to assess its significance in tree survival. Study trees were well distributed across the five possible cambium kill categories (Table 4) and the number of RTB attacks was well distributed among the study trees (Table 5). The number of RTB attacks was also well distributed among the five cambium kill categories with trees sustaining high levels of cambium kill generally having higher numbers of RTB attacks and trees sustaining low levels of cambium kill generally having lower numbers of RTB attacks (Table 6). In addition, the number of RTB attacks was recorded for each quadrant corresponding with a cambium sample to determine any relationships between attack pattern and cambium condition. Low numbers of RTB attacks were strongly associated with live cambium samples and high numbers of RTB attacks were strongly associated with dead cambium samples (Table 7).

Table 6. Number of RTB attacks by CKR in first year post-burn (and the number attacked by western pine beetle (WPB) by second year post-burn).

CKR	1–5 RTB	6–10 RTB	11–15 RTB	16–20 RTB	21+ RTB
0	27 (3)	7 (0)	10 (2)	11 (1)	7 (1)
1	16 (0)	13 (4)	13 (2)	8 (2)	6 (1)
2	4 (0)	5 (1)	3 (0)	6 (3)	11 (2)
3	0 (0)	2 (0)	2 (1)	2 (1)	9 (4)
4	1 (0)	3 (2)	2 (1)	6 (4)	18 (8)

Table 7. Percent live and dead cambium samples by number of RTB attacks per bole quadrant.

# of RTB in quadrant	% dead samples	% live samples
0 (n=155)	15%	85%
1 – 5 (n=385)	32%	68%
6 – 10 (n=135)	49%	51%
11 – 15 (n=54)	59%	41%
16+ (n=43)	86%	14%

Western pine beetle attacks were recorded for individual study trees during the first two annual evaluations (2004 and 2005). Trees that received high levels of cambium kill and red turpentine beetle attacks were attacked at a slightly higher rate by western pine beetle (Tables 5 and 6).

Post-fire mortality of study trees followed a typical pattern with most of the mortality occurring during the first three years (Table 8). Most of the observed mortality was concentrated in trees with high levels of cambium injury (Table 9) and high levels of RTB attacks (Table 10). As previously reported, these two variables were closely associated. 91% of the trees that had fewer than 6 RTB attacks also had CKR's equaling 0 or 1.

Figure 1. Tree mortality by year.

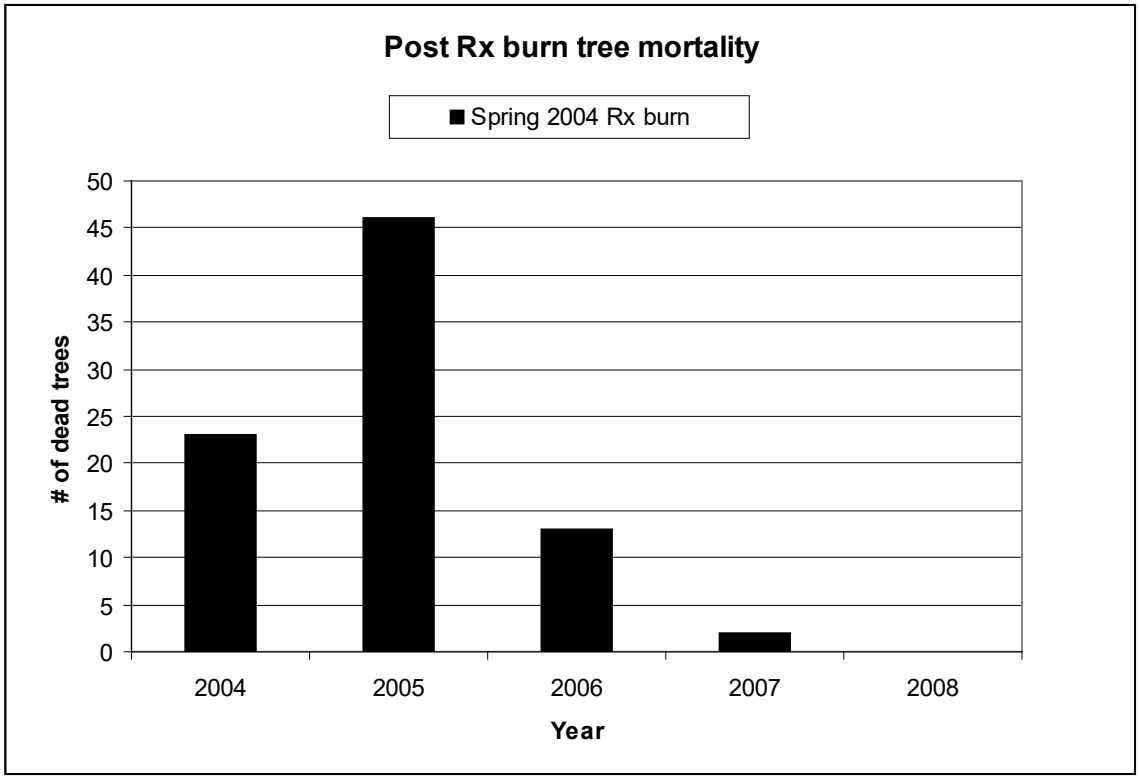


Table 9. Percent survival by cambium kill rating (CKR).

Cambium Kill Rating	% survival
0	84 %
1	73 %
2	41 %
3	7 %
4	7 %

Table 10. Percent survival by number of RTB attacks.

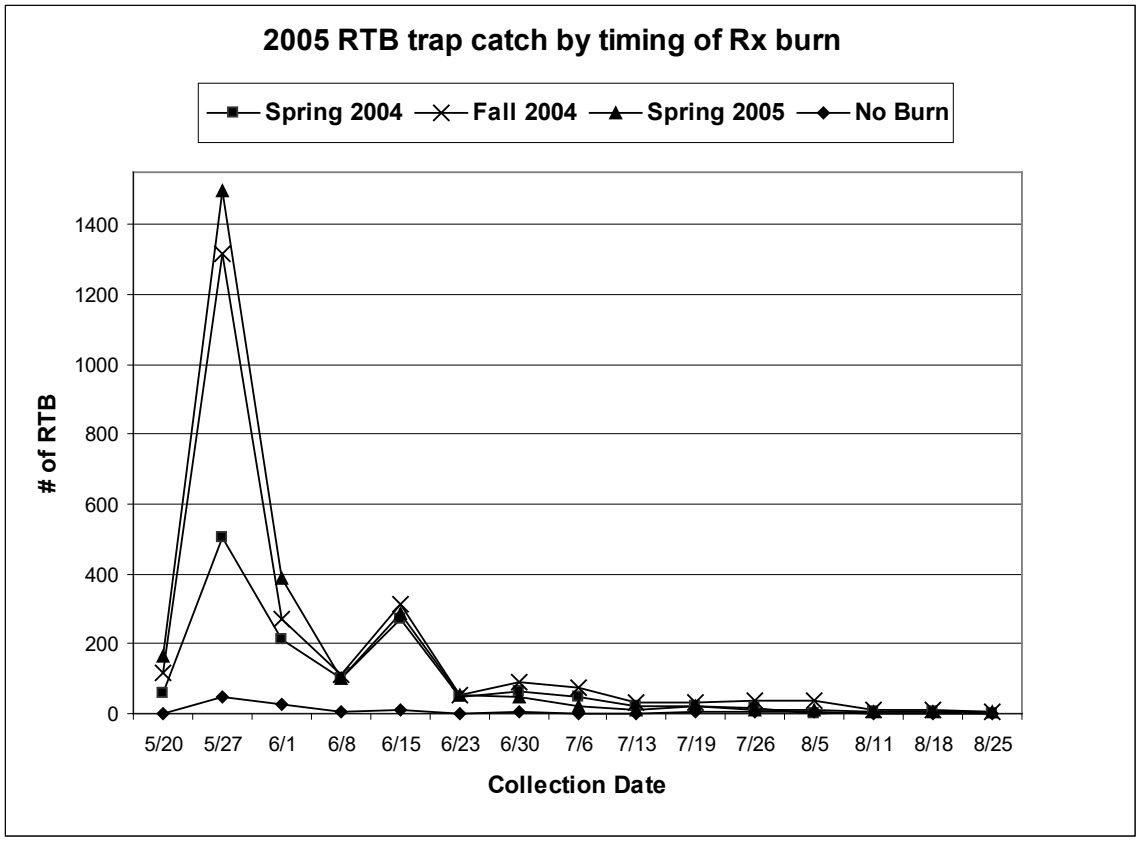
# of RTB	% survival
1 -5	83 %
6 - 10	50 %
11 - 15	68 %
16 - 20	52 %
21+	27 %

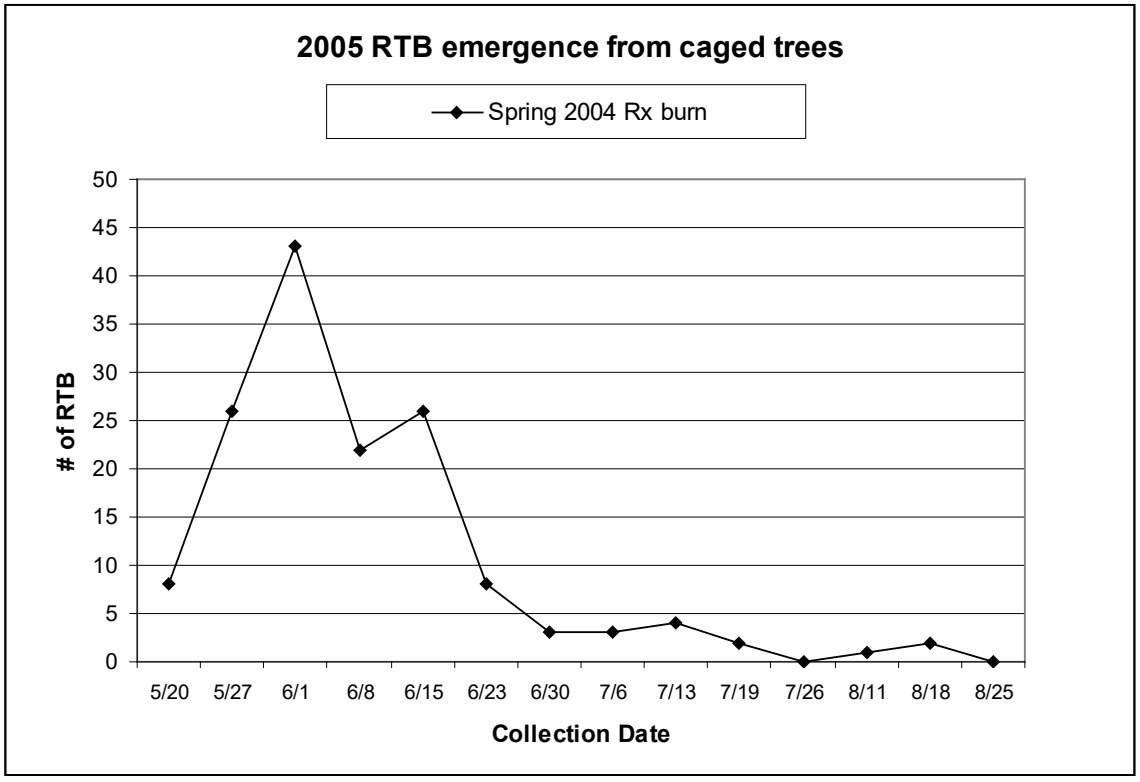
The fall rate of fire-killed trees also appears to be following a typical pattern where the first trees begin to fall in the third post-fire year (Table 11).

Table 11. Total number of snags and downed trees by year.

2004 # of Snags / # Down	2005 # of Snags / # Down	2006 # of Snags / # Down	2007 # of Snags / # Down	2008 # of Snags / # Down
23 / 0	69 / 0	71 / 10	50 / 34	28 / 56

RTB TRAPPING


2005 RTB trap catch by timing of Rx burn
Spring 2004
Fall 2004
Spring 2005
No Burn
# of RTB
1400
1200
1000
800
600
400
200
0
5/20
5/27
6/1
6/8
6/15
6/23
6/30
7/6
7/13
7/19
7/26
8/5
8/11
8/18
8/25
Collection Date


2005 RTB emergence from caged trees
Spring 2004 Rx burn
# of RTB
50
45
40
35
30
25
20
15
10
5
0
5/20
5/27
6/1
6/8
6/15
6/23
6/30
7/6
7/13
7/19
7/26
8/11
8/18
8/25
Collection Date

DISCUSSION

Most of the mortality observed in the Prattville Underburn occurred in trees that sustained high levels of cambium injury and nearly every tree (91%) that sustained a cambium kill rating (CKR) of 3 or 4 died despite minimal crown injury. These results are similar to FHP post-fire monitoring for fire-injured pines of similar diameters (10 – 20" DBH) in the 2002 Cone Fire, Lassen NF, and the 2000 Divide Underburn, Tahoe NF. In the Cone Fire, about 75% of the trees with minimal crown injury and a cambium damage rating of four died within 2 years post-fire. In the Divide Underburn, Tahoe NF, 43 out of 50 trees died that had a CKR of 3 or 4 and greater than 40% remaining live crown.

RTB strongly associated with CKR. Not able to use RTB as a predictor except for??

Mortality has mostly subsided by year 4 and little additional mortality is expected.

In the future, if brush is to be both masticated and burned, it may be necessary to rake some of the chips away from the bases of trees that are to be maintained as residuals or allow enough time between mastication and the underburn to allow the chipped material to decompose enough to alter the flammability and heat intensity.

Information obtained from this prescribed fire has greatly contributed to our knowledge on the effects of fire-injuries and RTB attacks to tree survivability and has also increased our awareness as to the high level of cambium injury that can be expected when burning in stands where heavy surface fuel loadings, consisting mostly of dense brush, are present.

Timing

In conclusion, FHP greatly appreciate the cooperation of District personnel in setting up and completing this study and look forward to working with you again as opportunities arise. Please contact me if you have any questions.

/s/ Danny Cluck

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APPENDIX A